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BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Application Number: 10/757,770
Filing Date: January 14, 2004
Appellant(s): YUAN ET AL.

Eugene J. Bernard
For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed 21 March 2008 appealing from the Office action mailed 21 August 2007.

(1) Real Party in Interest

A statement identifying by name the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

The examiner is not aware of any related appeals, interferences, or judicial proceedings which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

(3) Status of Claims

The statement of the status of claims contained in the brief is correct.

(4) Status of Amendments After Final

The appellant's statement of the status of amendments after final rejection contained in the brief is correct.

(5) Summary of Claimed Subject Matter

The summary of claimed subject matter contained in the brief is correct.

(6) Grounds of Rejection to be Reviewed on Appeal

The appellant's statement of the grounds of rejection to be reviewed on appeal is correct.

(7) Claims Appendix

The copy of the appealed claims contained in the Appendix to the brief is correct.

(8) Evidence Relied Upon

6,218,268	XIA ET AL.	4-2001
6,500,771	VASSILIEV ET AL.	12-2002
6,013,584	M'SAAD	1-2000
2002/0050605	JENQ	5-2002

(9) Grounds of Rejection

The following ground(s) of rejection are applicable to the appealed claims:

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.

4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

Claims 1, 5, 8-11,13-14,19-22, and 24 are rejected under 35 U.S.C. 103(a) as being unpatentable over US Patent number 6218268 to Xia et al.

Regarding claim 1, Xia et al. discloses a method of filing a gap defined by adjacent raised features on a substrate in column 1 lines 32-45. Xia et al. discloses a first step of using a flow of oxidizing, silicon-containing, and phosphorus-containing gas to deposit a BPSG film, or conformal layer, on a substrate and a second step of depositing another film, or bulk layer, using a flow of oxidizing, silicon-containing, and phosphorus-containing gas on a temperature below 500 °C throughout the deposition (column 2 lines 23-60 and columns 11 and 12 et seq.). In order to form the film on the substrate of Xia et al., one of ordinary skill in the art would recognize that these gases must react with one another. The ratios of the gases can be varied at the beginning and end during depositing the conformal layer (Figures 7A and 7B steps 706 and 709 show

the ratio being reduced during the deposition, also column 13 lines 4-42) and are constant in the bulk layer. Xia et al. does not explicitly include varying the ratios of gases between the beginning and end of the depositing of the conformal layer. However, Xia et al. teaches that the conformal layer has high doping and hence improved reflow properties, while the bulk layer has lower doping and enhanced film stability (column 2 lines 35-40). In column 3 lines 45-50, Xia et al. describes the two layers as improving gap filling, thickness uniformity, and film stability over a one-layer film. Different effects of differing ratios of changing gas amounts are shown in Table 1 of Xia et al. Xia et al. notes that higher ozone:teos ratios improves film conformity but has a low deposition rate, and the two-step deposition process reduces overall deposition time (column 11 lines 55-67). The concentration of dopant the second layer or bulk layer protects the conformal layer (column 12 lines 54-58), and most importantly, Xia et al. discloses that the recipe of the conformal layer may be modified to enhance conformation in column 12 lines 51-54. Therefore, in view of the abovementioned benefits of varying dopant, or phosphorous content, in the film it would have been obvious to one of ordinary skill in the art a the time of the invention to vary the phosphorous content during deposition of the conformal layer to improve conformity by routine experimentation and to improve stability of the overall film. Further, “a person of ordinary skill has good reason to pursue the known options within his or her technical grasp. If this leads to the anticipated success, it is likely the product not of innovation but of ordinary skill and common sense.” (*KSR International Co v. Teleflex Inc.,* 550 US--, 82 USPQ2d 1385(2007)). Therefore, one of ordinary skill in the art who

possesses the knowledge of making a graded dopant concentration within a film, would find it within their known options to use a graded dopant concentration to receive the above benefits, knowing that if two layers with two dopant concentrations improved over one layer it follows that one would want a layer made up of many dopant concentrations to improve over two dopant concentrations.

Xia et al. is described above and includes all of the provisions of claim 5 except a capping layer deposited at below 500 °C. Xia et al. teaches that a BPSG layer according to the described invention can be used in any of the dielectric layers 227, 228, and 229 in Figure 2 (columns 9 and 10 lines 55-3). The dielectric layers 227, 228, and 229 are shown to have three separate layers, the topmost of which can be considered a capping layer. It would have been obvious to modify the method of Xia et al. to include another layer in the disclosed process as a capping layer as shown in Figure 2 in order to make a layer that can be used in any dielectric layer in an integrated circuit.

With regard to claims 8-11, Xia et al. includes the recitations as described in the paragraph above, and includes the substrate as a semiconductor (column 1 lines 15-20) and the BPSG layer formed as a pre-metal dielectric layer (column 9 lines 55-60). Again the substrate is maintained at a temperature below 500 °C during deposition, which one of ordinary skill in the art would recognize as below reflow temperature of the silicon oxide and an annealing step is not disclosed. Thus Xia et al. meets all the recitations of claims 8-11, at least as broadly recited by claims 8-11.

With regard to claims 13-14, Xia et al. includes the recitations of claim 13 as discussed above, and discloses the silicon gas as TEOS and the phosphorus gas as TEPO in column 6 lines 15-31. Xia et al. meets all the recitations of claims 13-14, at least as broadly recited by claims 13-14.

All of the elements of claims 19-22 and 24 are disclosed by Xia et al. as described above. Xia et al. meets all the recitations of claims 19-22 and 24, at least as broadly recited by claims 19-22 and 24.

Claims 2, 3, 6 and 7 are rejected under 35 U.S.C. 103(a) as being unpatentable over Xia et al. in view of US Patent number 6013584 to M'Saad. Xia et al. is described above and includes making patterned metal over the BPSG layers in column 10 lines 1-12. Xia et al. does not include keeping the temperature at the substrate below the temperature of the silicon oxide or annealing the substrate during patterning. M'Saad teaches that it is not necessary to reflow the film but one can use a chemical mechanical polishing technique to planarize the film before depositing the metal so the temperature would not be raised, and one would assume the temperature would not be raised to reflow temperature when dealing with BPSG films in order to not reach temperatures that are too high for thermal budgets required for advanced pre-metal dielectric layers in smaller geometries (column 2 lines 21-60).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify Xia et al. to include the temperature of the substrate as below the

reflow temperature during metal deposition as taught by M'Saad in order to meet thermal budgets required for advanced pre-metal dielectric layers in smaller geometries.

Claims 4,12, and 23 are rejected under 35 U.S.C. 103(a) as being unpatentable over Xia et al. in view of US Patent publication 2002/0050605 to Jenq. Xia et al. is described above and includes a BPSG layer as a pre-metal dielectric layer but does not include a substrate comprising nickel silicide. Jenq teaches using a substrate comprising nickel silicide when depositing a BPSG layer as a pre-metal dielectric layer because nickel silicide is known to have desirable characteristics for reduced line width devices. (Paragraph 0021 lines 12-14 and paragraph 0025 et seq.)

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify Xia et al. to include nickel silicide in the substrate as taught by Jenq in order to take advantage of the desirable characteristics of nickel silicide in reduced line width devices.

Claims 15-18 and 25-28 are rejected under 35 U.S.C. 103(a) as being unpatentable over Xia et al. in view of US Patent number 6500771 to Vassilev et al. Regarding claims 15, 17, 25, and 27, Xia et al. is described above and includes a method for depositing BPSG that includes an oxidizing, silicon-containing, and phosphorus-containing gas or a plasma. Xia et al. does not include the phosphorus-containing gas flowing after the silicon-containing and oxidizing gas. Vassilev et al. includes a phosphorus-containing gas flowing after a silicon-containing and oxidizing

gas in the form of plasma in column 15 lines 34-52 to limit unacceptable dopant migration during processing (column 2 lines 27-33).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify Xia et al. to include the phosphorus-containing gas flowing after the silicon-containing and oxidizing gas in the form of a plasma as taught by Vassilev et al. in order to limit unacceptable dopant migration during processing.

Regarding claims 16 and 26, Xia et al. discloses the chamber pressure to be between 200 and 700 torr in column 13 lines 4-21.

Regarding claims 18 and 28, Vassilev et al. discloses the plasma density to be within a range including 10^{11} ions/cm^3 in column 15 lines 63-65.

(10) Response to Argument

The applicant argues that Xia et al. teaches away from using a graded dopant concentration as described in the claims, and in support cites a passage from Xia detailing previous experimental problems found with varying both the TEOS and the phosphorus concentration together. However, Xia goes on to describe, between the cited sections in column 14 and after in columns 14 and 15 et seq., methods used to correct for dopant deficiencies so these problems are minimized or do not occur, therefore making this argument not persuasive, absent other evidence. Specifically in column 15, lines 16-20, Xia et al. teaches that the valve 914 in Figure 9 “could be a proportional valve that allowed a gradual, or ramped, diversion of dopant from one output to the next." Clearly, when viewing figure 9 and reading columns 14 and 15 et seq., the dopant flow runs to the exhaust and then is gradually diverted from exhaust to

the chamber, giving a gradual change in ratio, or dopant, as required by the claims. It is noted that as the claims are written, only one variation in ratio is required during the deposition of the conformal layer, and not a continuous variation as the applicant often cites in the instant arguments. Xia et al. makes obvious using such a graded dopant concentration given the various disclosures and motivations given here and in the previous office action:

In columns 14-15 lines 41-3 and Figures 10 and 11, Xia et al. shows variation in dopant concentrations in order to avoid creating a dopant deficient region between the conformal and bulk layers and hence to avoid impeding reflow properties, thus giving motivation for gradually changing the ratio of dopant in the conformal layer to meet the desired concentration of the bulk layer. Xia et al. notes that higher ozone:teos ratios improves film conformity but has a low deposition rate, and the two-step deposition process reduces overall deposition time (column 11 lines 55-67). The concentration of dopant the second layer or bulk layer protects the conformal layer (column 12 lines 54-58), and most importantly, Xia et al. discloses that the recipe of the conformal layer may be modified to enhance conformation in column 12 lines 51-54. Therefore, in view of the abovementioned benefits of varying dopant, or phosphorous content, in the film it would have been obvious to one of ordinary skill in the art a the time of the invention to vary the phosphorous content during deposition of the conformal layer to improve conformity by routine experimentation and to improve stability of the overall film. In further support, “a person of ordinary skill has good reason to pursue the known options within his or her technical grasp. If this leads to the anticipated success, it is likely the

product not of innovation but of ordinary skill and common sense." (*KSR International Co v. Teleflex Inc.,* 550 US--, 82 USPQ2d 1385(2007)). Therefore, one of ordinary skill in the art who possesses the knowledge of making a graded dopant concentration within a film, would find it within their known options to use a graded dopant concentration to receive the above benefits, knowing that if two layers with two dopant concentrations improved over one layer it follows that one would want a layer made up of many dopant concentrations to improve over two dopant concentrations.

(11) Related Proceeding(s) Appendix

No decision rendered by a court or the Board is identified by the examiner in the Related Appeals and Interferences section of this examiner's answer.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

/Kelly M. Stouffer/
Examiner
Art Unit 1792

Conferees:

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